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PRODUCTION AND USE OF MACHINE TOOLS IN THE ENGINEERING INDUSTRY OF ESCAP DEVELOPING COUNTRIES

Final Report of the UNIDO/ESCAP Technical Working Group

Hosted by TECHNONET ASIA Singapore, 17–21 November 1986

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Preface

At the recommendation of the 9th Session of the ESCAP Committee on Industry, Technology, Human Settlements and Technology held in Bangkok from 10 to 16 September 1985, UNIDO, Sectoral Studies Branch and the ESCAP/UNIDO Division of Industry, Human Settlements and Technology have organized a Technical Working Group on Production and Use of Machine Tools in the Engineering Industry of ESCAP Developing Countries. The Technical Working Group, which was held in Singapore from 17 to 21 November 1986 and hosted by TECHNONET ASIA, has been a direct follow-up of the UNIDO/ESCAP project on "Review and appraisal of industrial progress at regional level".

The participants to the Technical Working Group have formulated concrete conclusions and recommendations at regional and national levels, which are contained in the present Final Report of the meeting. Specific action for joint work for UNIDO and ESCAP was also suggested, inter alia, the organization of study tours to machine tools industry of countries of the ESCAP Region, and of workshops for training of trainers at both managerial and plant levels. The organization of a training programme on CAD/CAM and to establish a mechanism to facilitate the exchange of CAE technology among developing countries in the form of information, personnel and software. At national level eleven projects were identified for technical assistance from UNIDO to the users and producers of machine tools of the countries of the region.

CONTENTS

		Page
1.	ORGANIZATION OF THE TECHNICAL WORKING GROUP	1
2.	PRESENTATION OF THE ISSUES	4
	A. The role of computerized technology in manufacturing process	5
	B. Flexible automation in the engineering industry in industrialized countries and perspectives for developing countries	8
	C. Technological requirements to entry into the machine tool industry and the upgrading to CNC machine tools	14
	D. The machine tool industry in ASEAN countries	16
	E. Local needs of machine tools in LDCs of the ESCAP region	20
3.	CONCLUSIONS AND RECOMMENDATIONS	22
	A. Regional level	23
	B. Project proposals at country level	25
ANNEX I	- List of participants	27
ANNEX II	- Programme and schedule of plant visits	29
ANNEX III	- List of documents	33
ANNEX IV	- Project proposals on the technical assistance to the machine tools industry identified at country level	34
EXTRACTO - SOMMAIRE		37

EXPLANATORY NOTES

References to dollars ($) are to United States dollars, unless otherwise stated.

A comma (,) is used to distinguish thousands and millions.

A full stop (.) is used to indicate decimals.

A slash between dates (e.g., 1980/81) indicates a crop year, financial year or academic year.

Use of a hyphen between dates (e.g., 1960-1965) indicates the full period involved, including the beginning and end years.

Metric tons have been used throughout.

The following forms have been used in tables:

Three dots (...) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A blank indicates that the item is not applicable.

Totals may not add up precisely because of rounding.

Besides the common abbreviations, symbols and terms and those accepted by the International System of Units (SI), the following abbreviations and contractions have been used in this report:

Economic and technical abbreviations

GDP	Gross domestic product
LDC	Least developed country
MVA	Manufacturing value added
R and D	Research and Development
SITC	Standard International Trade Classification
t/a	Tons per annum
TCDC	Technical co-operation between developing countries
TNC	Transnational corporation

1. ORGANIZATION OF THE TECHNICAL WORKING GROUP

Introduction

The Technical Working Group on production and use of machine tools in the engineering industry in ESCAP developing countries, was convened at Singapore from 17-21 November 1986. It was attended by national experts from Burma, India, Republic of Korea, Malaysia, Nepal, Pakistan, People's Republic of China, Philippines, Singapore and Thailand; and international experts from Sweden and the United Kingdom. As observer, the following institution also attended the Technical Working Group: E. M. Tools Pte. Ltd. As a non-governmental organization of the Asian region, TECHNONET ASIA hosted the Technical Working Meeting and provided the necessary secretarial support and assistance. The list of participants is attached as annex I.

UNIDO's Studies and Research Division and the ESCAP/UNIDO Division of Industry, Human Settlements and Technology have, since 1982, jointly carried out a project on "Review and appraisal of industrial progress at the regional level". This project has been executed in two phases. Phase I of the project consisted primarily of analysis of statistical data and a summary was prepared under the title "Industrialization trends in developing ESCAP countries" (E/ESCAP/IHT.6/10). Phase II of the project included the preparation of several sectoral studies, for sectors of specific interest for the region. The selected sectors were: capital goods industries, iron and steel, petrochemical and chemical industries and wood and wood products.

The studies prepared by national consultants and by the secretariats of UNIDO and ESCAP were submitted for discussion in the "Workshop on Accelerated Growth Through Co-operation in Selected Industrial Sectors in the Developing Countries of the ESCAP Region" which was convened at Bangkok from 1-5 July 1985. The final report of the Workshop as adopted by the participants was issued as document UNIDO/IS.543. The conclusion and recommendations of the workshop were endorsed by the ESCAP Committee on Industry, Technology, Human Settlements and the Environment, 9th Session, held in Bangkok from 10-16 September 1986. The Committee directed the Secretariat to undertake follow-up activities on the basis of recommendations of the workshop.

Conclusions and recommendations for each of the selected sectors were formulated. In the case of capital goods priority was given to the organization of a seminar on numerically controlled machine tools:

> "(c) ... It is also suggested that UNIDO and ESCAP jointly organize a seminar on computer numerically controlled machine tools in order to formulate a strategy among the countries of the region for the further development of this industry at regional level." (UNIDO/IS.543, p.21).

Opening session

Dr. Leon V. Chico, Executive Director of TECHNONET ASIA welcomed the participants to the Technical Working Group and wished them a fruitful and pleasant stay in Singapore. He expressed his appreciation to UNIDO and ESCAP for giving TECHNONET the opportunity to host and participate in this important

activity. Briefly, he explained TECHNONET's mission and programme in the promotion and development of small and medium industries with particular emphasis to technological aspects. He stressed that technology, particularly in the metalworking and engineering sectors, was a key ingredient in upgrading the productivity of SMI's in order to make them competitive in the international marketplace. He cited the successes of NIC's in the region in this regard and deplored the fact that some countries do not give due importance to technological development.

The representative from ESCAP also welcomed the participants and explained how the Technical Working Group originated from a joint UNIDO/ESCAP project on industrial sectors and the special emphasis given in the project to the capital goods industries, because these industries not only provide the critical inputs for downstream manufacturing, but also function as nurseries in which skills and managerial capabilities grow. In this context, he also related that the machine tool industry is generally regarded as strategic, and within the metalworking industry plays a key role in the expansion of industrial production since every branch of manufacture, whether for durable consumer goods or for machinery and equipment, is dependent on machine tools.

The representative of UNIDO after welcoming the participants expressed gratitude to TECHNONET ASIA for hosting the Technical Working Group. He further explained the role of UNIDO in promoting industrialization of developing countries and the emphasis now given to provide technical assistance, which are supported by a research and study programme at regional, national and sectoral levels, including the promotion of technological development and the acquisition of modern technologies. He also expressed that the main objective of the Technical Working Group will be to provide a forum for consideration of the specific problems faced by the engineering industry of the ESCAP developing countries in the production, utilization, maintenance, and repair of machine tools and their accessories, with focus on the introduction and use of computer numerically controlled machine tools, in order to formulate a strategy among the countries of the region for the further development of this industry, and to define ways and means for technical assistance to be provided by UNIDO.

Election of officers

The Technical Working Group unanimously elected Mr. Chan Kai Mun (Singapore) as Chairman; Mr. Constante Ventura (Philippines) as Vice-Chairman and Mr. S.K. Palhan (India) as Rapporteur.

Agenda, programme and organization of work

The Technical Working Group adopted the following agenda:

(a) Opening of the UNIDO/ESCAP Technical Working Group
(b) Election of Chairman, Vice-Chairman and Rapporteur
(c) Adoption of the agenda and organization of the work
(d) Presentation of the issues
(e) Discussion of the issues
(f) Conclusions and recommendations for further action
(g) Adoption of the report.

The programme adopted by the Technical Working Group is attached as annex II.

Documents

The list of documents is attached as annex III.

Adoption of the report

The report was adopted by the meeting on 21 November 1986.

2. PRESENTATION OF THE ISSUES

More than ten years have passed since the last UNIDO seminar on the promotion and development of the machine tool industries in Asia was held. Naturally some countries in the subregion have made significant progress in the development of machine tools and may be ready to support the technology transfer to other countries of the region. The necessity has arisen to analyse the above mentioned changes in the national machine tools stocks, to determine the tendencies of development in this field in eighties and to outline the ways to improve efficiency of use and production of machine tools and their further expansion in the subregion. In this connection it is worthwhile to underline the recent developments in the machine tool industry in some LDCs: In Bangladesh a basic infrastructure exists and UNIDO has already provided technical assistance to this country. Nepal has just considered the installation of machine tools specially for the manufacturing of agricultural implements.

The main objective of the Technical Working Group was to provide a forum for consideration of the specific problems faced by the engineering industry of the countries in the production, utilization, maintenance and repair of machine tools and their accessories, with focus on the introduction and use of computer numerically controlled machine tools, in order to formulate a strategy among ESCAP developing countries for the further development of this industry at regional level.

The discussions in the UNIDO/ESCAP workshop on Selected Industrial Sectors referred to above, focussed on the role of the microelectronics industry which most participants believe has one of the best potentials for increasing productivity in all sectors. Whoever masters the electronics industry controls the future means of production because the next generation of capital goods industry will have a significant microelectronics component. Countries in the ESCAP region were urged not to neglect the development of this country. Not every country has to get into the production of electronics hardware but all countries should seriously consider paying some attention to the development of electronics software. There is a need to understand and learn how to link existing machinery with microprocessors and with computers. The introduction of computer numerically controlled machine tools, will result in an important technological development and will have a significant influence on the industrial development of the region in the next decade.

Several sectoral studies have pointed out that the machine tool industry is of critical importance in capital goods technology.[1/] It covers a wide range of equipment for metal cutting and metal forming and varies in technical complexity. In developing countries with no capital goods industry and also in countries with only an embryonic base products and technology have to be very carefully selected in order to avoid initially highly complex technologies which cannot be readily absorbed. Experience in machine tool

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1/ See, UNIDO, Capital goods industry in developing countries: a second world wide study. Sectoral Studies Series No.15, Volume I (1985), UNIDO/IS.530 and Preliminary analysis of the capital goods industry in South-East and East Asia, Sectoral Working Paper Series No.34, 1985, UNIDO/IS.563.

manufacture shows that in countries where there is an adequate growth of technological infrastructure, technology acquisition through licensing from industrialized countries may be desired to entry into further stages of technological complexities.

The discussions of the Technical Working Group considered, therefore, the issue to develop and promote the use and production of machine tool and CNC machine tools in the engineering industries of ESCAP developing countries and especially:

(a) A first approach to the formulation of technical assistance programmes for the machine tool sector of the engineering industries;

(b) Actions for improving the transfer of technology in the machine tools industry from developing countries of the region where this industry already exists;

(c) Identification of possibilities of co-operation in the machine tool industry among ESCAP developing countries;

(d) Specification of budget requirements for financing adequate technical assistance programmes by international funding agencies.

In this connection, therefore, the following was also analyzed:

i. Up-grading of the existing machine tools industry of the ESCAP developing countries (this relates both to the use and the production of machine tools).

ii. The needs of machine tools and CNC machine tools of the engineering industry in the countries concerned was assessed in the UNIDO and ESCAP background documents in general, and through the presentation by participants from the countries in particular.

Summary of discussions

A. The role of computerized technology in manufacturing process - a summary of the presentation by Mr. Zielinski

The lecture given by Mr. Zielinski presented trends and features in up-to-date technology and engineering industry. A new manufacturing philosophy was discussed together with new engineering activities which should be created and implemented within the industry. To achieve the internal demands as well as the needs of the international market in terms of quality and quantity, special emphasis should be placed on the introduction of Numerical Control Technique within engineering industries of developing countries. The manufacturing process as a chain of activities was analyzed and a system's approach providing a single framework for integrating functional areas was discussed. The role of machine tools numerically controlled was emphasised and the main reasons for their implementation were discussed and analyzed.

In this context, engineering computer applications are frequently identified with the automation of engineering work - to diminish personal workload, lower costs and shorten the engineering phase (lead-time) of

project or product development. Those particular consequences, although of considerable importance, are of a quantitative nature and do not constitute the computers originated qualitative change in engineering.

These changes are based on the following main achievements:

(a) New approaches to engineering, i.e. the transition from the traditional heuristic procedures supported by occasional computational "checking" of critical parameters, to the mathematical modelling of various aspects of process or technical performance. This leads to computer-assisted optimum design synthesis;

(b) New approaches to production and manufacturing control, i.e. the treatment of the industrial cycle (research-design-prototyping-tests-production-maintenance) as a comprehensive system;

(c) New techniques of man-machine interaction in the engineering tasks, i.e. from batch made in computing and programming to conversational technique in problem oriented languages, applied by the engineers themselves; and

(d) New methods of analysis of universal application in engineering such as digital simulation of continuous and discrete dynamic processes, numerical optimisation of linear and non-linear multivariable problems etc.

Mr. Zielinski also pointed out that these trends and achievements bring the real qualitative change and result in the greatest economic benefits through better, optimized product or process characteristics, reducing much of the costly and time consuming modelling and prototype testing, and shortening the project and product lead time. These consequences, and not the automation of the engineers' work, cause the real great impact of computer-aided techniques upon design and manufacturing processes.

Summing up, it can be stated that the numerical control systems of today are characterized by the following facts:

- The microprocessor-based controllers drastically simplify the logic of many aspects of machine-tools control. It is also a fact that microprocessor developments have removed some of the more traditional dividing lines between performance capabilities of some types/ranges of control systems.

- Manual data input has become very popular and, as a result, there appears a desire to make available direct programming of a work-piece from the drawing, without any intermediate computations by the operator or the part-programmer.

- Conversational programming techniques are applied which guide the operator on the machine. Built-in graphic display screens provide numerous functions and facilities to simplify programming, editing and diagnosis.

The present day level of the development of NC systems, therefore, assures that their introduction into a factory brings significant benefits. It was also noted that the direct and most obvious effect of automation, i.e. diminishment of the human workload, is, in fact, one of the minor benefits particularly in the developing countries with their low cost of labour and large human resources (those resources being mostly amongst unskilled labour). In fact, what seems important in terms of real benefits may be summarized in the following points:

- NC technological equipment diminishes the need for highly qualified operators.
- Due to their high output NC machine tools are especially effective in removing "bottlenecks" always existing somewhere in the factory.
- NC machine tools assure very high repeatability of the parts, accuracy of dimensions and, as a consequence, stability of the end product - unattainable through conventional techniques.
- Due to the application of NC systems, which are characterized by closed loop control, many of the checking devices which are very costly and require highly skilled personnel, may be eliminated.

It was also mentioned that NC technological equipments are highly demanding devices. Due to their relatively high cost they have to be fully loaded with work. This demand, combined with the high output, necessitates good production planning and control. It is therefore necessary to think about computer aids to production preparation, planning and control - in fact to think about computerized system approach from the moment one starts to introduce NC technique into an industrial activity. This is also the point where industrial engineering activity integration begins.

There has been a good deal said and written recently about process integration through computer-aided design, computer-aided manufacturing and management control/information systems. This is mainly done with the fully automated factory being the ultimate goal for automation. As the speedy introduction of such a factory is not always the best solution in the developing countries the question was posed whether or not talking about computerized integration makes any sense in the context of the conditions of the developing countries. It was the speaker's firm belief that this is not the case and that there are much deeper reasons for such an approach than the most apprent one of reduction of personnel costs through automation. The most important reasons are:

i. The enforcement of technological discipline within the manufacturing organization (as all the computer systems involved usually require very orderly data inputs, engineering procedures, etc.);

ii. The introduction of greater flexibility into the manufacturing process, i.e. improving its ability to adapt quickly and effectively to any engineering changes, varying market demands and new product designs;

iii. The assurance of faultless and exact data acquisition for the management control;

iv. The assurance of faultless and highly accurate manufacturing of even complicated parts/operations (independently of the operator's skills); and

v. The improvement of the economical effectiveness of the manufacturing process through better planning, optimal production allocation, possibility of dynamic forecasting etc.

In the case of the developing countries it seems that points ii. and iv. above should be considered as the ones most important.

Regarding the production of modern machinery, the remark was made that their manufacture is impossible using manual techniques alone, particularly under conditions where there is a lack of very highly skilled operators with long industrial tradition in high technology manufacturing. It must be stressed that in the present day more and more products worldwide reach such a level of design complexity that their most important parts cannot be produced without NC equipment. Whilst in the early years of NC this was true, only in the case of some very specialized products (e.g. modern aircraft) have more and more products gradually come into this category. Disregarding this trend, and neglecting the introduction of NC into the national industrial organizations, leads to the inability of the national industry to manufacture and to use up-to-date equipment in more and more branches of industry. This has had the effect of deepening the dependence upon imports of such products and technology and broadening the well known "technological gap" between the developed and developing countries.

It should be stressed therefore that NC is the key to the industrial engineering systems approach and that CAD/CAM/CIM integration may be performed solely and only via the NC technique.

From the discussions, it emerged that the great changes taking place in metalworking may be attributed to the rapid developments in machine tool design and technology, control engineering and production concepts. In fact, developments relating to new materials, cutting tools and new generation of drives are not only influencing the concept of machining, but also adding a new dimension to the machine tool design, and machine tool control systems.

B. Flexible automation in the engineering industry in industrialized countries and perspectives for developing countries - a summary of the presentation by Professor Charles Edquist

The ongoing introduction of flexible automation devices in the engineering industry of the industrialized countries constitutes a revolutionary technological breakthrough. It is the most important technological transformation in the capital goods sector since the introduction of electricity and the steam engine. This technological breakthrough occured after a long period of relative stability with regard to production technology in the capital goods sector. The consequences of flexible automation for productivity organization of production, competitiveness and employment will be comprehensive in the next few decades.

The most important microelectronics based technologies in the capital goods sector are:

- Computer numerically controlled machine tools (CNCMTs).
- Computer-aided design (CAD) systems.
- Industrial robots (IRs).
- Flexible manufacturing systems (FMS).

These four technologies are together often called CAD/CAM technologies or flexible automation technologies. They are the main elements of the "factory of the future" in the engineering industry. The first three of them are well known and need not be described here. FMS, however, can take many forms. A flexible manufacturing module (FMM) consist of a stand-alone CNCMT, material handling equipment (e.g. a robot or a pallet changer) and some kind of monitoring system. A flexible manufacturing cell (FMC) usually consists of a number of machine tools and material handling devices. A flexible manufacturing system (FMS) proper often contains several automated machine tools, FMMs and FMCs. These are interlinked by an automatic workpiece flow system which enables the simultaneous machining of different workpieces which pass through the system along different routes. (What follows is partly based on a forthcoming book by Charles Edquist and Staffan Jacobsson. It is entitled "Flexible automation in the engineering industry of OECD and third world countries" and will be published during 1987. A number of tables on the diffusion of flexible automation techniques emanating from this book were included in the presentation, but they are not reproduced in this summary.)

The use and diffusion of flexible automation technologies

The technological transformation mentioned is primarily taking place in the OECD countries. However, the four technologies listed above are also diffused to the more advanced developing countries - although at a slower speed.

The process of automation in the industrialized countries has reduced the input of labour per unit of output - and, thereby often the total cost of production. The factor saving bias differs between the four technologies. In some cases the automation technologies may even be capital saving. CNCMTs and CAD may also be skill saving. CNCMTs save on skilled labour in the form of operators of conventional machine tools. However, at the same time other skills are needed, e.g. capabilities to programme, set, maintain and repair the CNCMTs. (The repair and maintenance task has become more complex. However, the amount of repair and maintenance work per unit of output may have decreased at the same time since one CNCMT replaces several conventional machine tools.) CAD software contains accumulated knowledge. At the same time new skills are needed to operate, maintain and repair the CAD units. Hence, these technologies save on some skills, but other are needed instead. On the whole, however, both CNCMTs and CAD are skill saving in the sence that the mass of skills needed per unit of output is reduced.

The technological transformation in question certainly has important implications for the majority of the developing countries since they are a part of the same international techno-economic system as the OECD countries. (This includes, of course, also those developing countries to which the flexible automation technologies have not been diffused at all. Also these countries will be affected.) The technological gap between developed and developing countries as well as the magnitude and structure of production costs in various types of countries. Therefore, it also has consequences for the relative competitiveness of firms in various countries, for the international division of labour, subcontracting and other aspects of the international location of production. It is also within the international techno-economic context mentioned which the developing countries have to formulate their industrial and technology policies.

The electronics-based automation technologies have not been diffused to the same extent in developing countries as in the OECD ones and the diffusion has largely been limited to the most advanced developing countries. There are, however, certain differences between the four technologies. CNCMTs is the technology which has been diffused to the largest extent in the NICs. In spite of this the growth in the investment in CNCMTs in these countries is not large enough for them to catch up with the OECD countries. The diffusion of industrial robots has been very limited in developing countries partly due to the fact that robots mainly save on unskilled labour and requires new engineering skills at the same time. FMS is largely nonexistent in developing countries, mainly because it is an immature and very complex process technology. CAD systems have been diffused in the more advanced developing countries, e.g. the Republic of Korea and Singapore. However, CAD has a large potential of being diffused quite rapidly in developing countries thanks to the very recent and very substantial decrease in their cost, which is related to the emergence of personal computer based CAD systems. (In some developing countries pirat copies of PC-based CAD software can be bought for a few dollars.) Developing countries may be able to use CAD for leap-frogging in the field of design, since the CAD software embodies accumulated design and draughting experience. Such experience is currently a scarce resource in most developing countries, which is indicated by their heavy reliance on foreign technical licenses.

However, our knowledge is inadequate and, for example, the actual or potential consequences of flexible automation for the international division of labour and location of production are not known. Still, there are reasons to believe that the automation, in many cases, is a threat to further industrialization of developing countries and even sometimes to their present production of capital goods, because of the cost reduction of the new technologies. However, in other cases these technologies probably provide new opportunities for developing countries, which they should try to exploit. (The use of PC-based CAD - mentioned above - is an example of such an opportunity.) On the whole it is not known in which specific respects the new technologies provide threats and opportunities respectively, for developing countries. For this reason research is needed. Since the impact of the four techniques differ between themselves as well as between products for the production of which they are used, the research should be product specific. The studies should focus upon the economic impact of flexible automation on the production of specific engineering products in various kinds of developing

countries as well as in industrialized ones - i.e. an analysis of the global techno-economic context must be included. (A study programme along these lines was presented by the Sectoral Studies Branch of UNIDO in March 1986: "The impact on developing countries of flexible automation in the capital goods industry", Vienna, 25 March 1986.) Such product specific studies would illuminate the issues raised in paragraph 35 above. Thereby they would provide a basis for decisions about which products and product groups developing countries could and should avoid producing and, hence, continue to import. The studies could also identify necessary needs of assistance to the firms, from governments and international organizations.

About 40 to 60 per cent of all investment in machine tools is now in CNC machine tools, in the leading OECD countries. In many firms conventional machine tools are no longer even considered as an alternative. Mr. Zielinski and Mr. Wightman have, in their papers, presented several reasons why CNC machine tools are advantageous to conventional machine tools (productivity, flexibility, accuracy, etc.). Another one is the fact - mentioned above - that less skills are needed when CNC machine tools are used than when conventional machine tools are used. This makes the arguments for using CNC machine tools in developing countries even stronger - since there is a shortage of skills in most Third World countries. For these reasons many firms in developing countries have a strong interest in using CNCMTs.

This means that governments in many Third World countries should support and facilitate and use of CNC machine tools in their countries. However, there are also important obstacles to the diffusion of CNC machine tools in developing countries. (This discussion is based upon the concept of "Social carriers of techniques" which has previously been used in Charles Edquist's "Capitalism, Socialism and Technology - a comparative study of Cuba and Jamaica", Zed books, London, 1985.) These obstacles can be grouped under 3 headings:

(a) Information;
(b) Access; and
(c) Knowledge.

Lack of information is a substantial obstacle to diffusion of CNC machine tools in developing countries. The potential users do not have enough information about CNC machine tools and about the advantages attached to using them. This is particularly so for small and medium sized companies.

Governments and international organizations can intervene in various ways to facilitate the diffusion of information about CNC machine tools and their advantages. For example, information systems can be established and demonstration facilities can be provided.

Lack of access to CNC machine tools may be caused by financial constraints, import restrictions and political embargos. Also here governments may be helpful, e.g. by providing credit.

Lack of knowledge is probably the most important obstacle to diffusion of CNC machine tools in developing countries. It is a question of knowledge about how to:

- implement,
- operate,
- maintain, and
- repair

CNC machine tools. These obstacles can be mitigated through advice through consultants and through training programmes. Consultants are most useful in the implementation phase. Training is needed for the other stages. The fact that training is needed in spite of the skill saving nature of the use of CNC machine tools is a result of the need for certain new kinds of skills for the use of CNC machine tools - in particular skills to set and programme the machines.

The production of flexible automation technologies

The problem of production of flexible automation technologies is very different from the question of use and diffusion of these technologies. For example the technological capabilities needed are quite different. The production of the flexible automation technologies - which are also capital goods - is largely limited to the industrialized countries. The main exception is CNCMTs which are produced in some NICs in considerable quantities. On the whole, the flexible automation technologies can in the next decade only be produced in few developing countries. (However, CNCMTs and CAD are already being used in quite a large number of Third World countries.)

The following example was presented: The production of NC lathes increased - in the United States of America, Japan, Federal Republic of Germany, France, Italy and the United Kingdom taken together - from $US 479 million in 1976 to $US 1,492 million in 1984. The proportion of NC lathes of all lathes increased from 30 per cent to 73 per cent during the same period. During the same period the total production of conventional lathes decreased from $US 1,112 million to $US 559 million in current prices. This means that the market for conventional lathes was reduced to much less than half. However, with regard to grinding and polishing machines only 11 per cent of the production was numerically controlled machines in 1984 in the same countries. On the whole the use of numerical control is much larger for metal cutting (56 per cent) than for metal forming (19 per cent) machine tools. (These figures emanates from the book mentioned above.)

The developing countries must consciously choose which kinds of machine tools they shall produce if they want to continue production or enter the machine tool industry. The example presented above shows that the developing countries must be aware of the changes in the international techno-economic context when formulating their - necessary - strategies of specialization within the machine tool industry. For example, it is not a good idea to produce conventional lathes if a country wants to enter into large scale production and exports of conventional machine tools. It is a better strategy of specialization to produce grinding machines or metal forming machine tools

(as opposed to metal cutting machine tools) since the change-over to CNC is much slower in these products. (This is of course, true for countries which do not choose to produce CNC machine tools.) If a country has the capability and ambition to produce CNCMTs it should, ceteris paribus, specialize rather in lathes that in grinding machines. In other words, the fact that the proportion of CNC varies very much depending on the type of machine tool is absolutely crucial for the strategies of specialization of developing countries.

As argued above, it is necessary to formulate a strategy of specialization for all countries which have the ambition to produce machine tools in the future. And this strategy must be partly based upon a detailed analysis of the international techno-economic context with regard to the machine tool industry. A detailed analysis of this kind is absolutely crucial as a basis for a strategy of specialization within the machine tool industry in any developing country.

However, the formulation of a national strategy of specialization within the machine tool industry also requires detailed knowledge about existing domestic capabilities. In most developing countries such information is not available to the Ministry of Industry. (These Ministries often have access only to national macro data.) Therefore, a second precondition for the formulation of a strategy is a micro-oriented study which must include visits to and interviews with the firms already producing various kinds of machine tools. The team carrying out such a study should preferable include persons with economics as well as engineering competence.

On the basis of a detailed firm level study of existing domestic capabilities as well as a detailed analysis of the international techno-economic context with regard to the machine tool industry, a viable strategy for the future of the machine tools industry in the country can be formulated. (Incidentally, these two preconditions are necessary for strategy formulation with regard to all industries and products.) If a strategy is based upon the two kinds of studies mentioned, it can also - in specific terms - identify in which respects intervention from governments and international organizations are needed. It would also be possible to propose which kinds of specific policy instruments that would be most appropriate.

C. Technological requirements to entry into the machine tool industry and the upgrading to CNC machine tools - a summary of the presentation by Mr. Wightman

Mr. Wightman presented an explanation of the document prepared by him and issued as UNIDO/IS.642, concentrating his exposition on three main aspects:

(a) Definitions and main characteristics of the machine tool industry;

(b) Technological requirements for entry into the machine tool industry by developing countries; and

(c) Technological requirements for upgrading the existing machine tool industry in developing countries.

The main objective was to establish a framework of reference to describe the technology in the machine tool industry, deriving the salient characteristics from modern machine tool computer control systems, specially because the latter are seen to play a predominant role in shaping the industry through the impact of computer aids in the control of machines and in computer-aided design and manufacturing.

As a result of technological innovation, machine tools with improved design and better efficiency have been produced resulting in a high degree of specialization (e.g. type and size) among manufacturers and even among producing countries themselves. This development has made even the technically most advanced countries dependent on some machine tools imported from other countries. Likewise, this development has led to breaking up the monopoly of "developed" countries as regards machine tool production. Presently, there is a polarization in machine tool production with high technology machines produced by the developed countries due to their highly advanced industrial base and infrastructure on one hand, with conventional and general purpose machine tools being produced by the developing countries, on the other.

Over the years, the basic functions of machine tools in terms of metal cutting and metal forming have remained virtually unchanged. What has undergone a radical evolution however, is the design and construction of machine tools, particularly in the technology that dictates the method of motion insofar as metal cutting and forming are concerned. Where early machine tools were manually controlled, the machine tools of today are becoming more sophisticated and will continue to be even more so in the future as technological advances in computer hardware and software are adopted by design and manufacturing sections of the industry.

The most important function of NC is its accurate positioning of the tool in relation to the workpiece by means of signals or commands from a pre-programmed source in the form of numerical coding on punched paper tape, or in the form of magnetic tape or punched cards. Other NC functions include selecting the proper tool from a magazine and controlling the speed and direction of spindle rotation. The advances brought about by NC were instrumental in the development of machining centres and lathes, as heretofore it was impossible to control more than two axes simultaneously.

Besides NC, other types of control for machine tools are programmable control (PC), direct numerical control (DNC), and most notably - the computer numerical control (CNC). Programmable control allows the machine tool operator to interrupt the programme at any time and insert another operation or machining sequence. Direct numerical control is a method by which a common computer directly controls one or more numerically controlled machine tools. The computer can also be used to provide information on machine utilization and for production reports.

CNC systems utilize microcomputers to store machining programmes in read-only memories (ROM). Their advantages include their adaptability to different types of machine tools, ease of programming and information retrieval, and the ability of one computer to simultaneously control one or more machine tools, for example, in group technology cell applications.

It was further explained that there are several specific ways in which developing countries may employ CNC machining centers, progressively update the existing machine tools and use computer aids in the planning and manufacture of machines embodying CNC systems. In this connection, a seven-stage plan was identified, including:

- technology levels
- criteria for determining the need to upgrade labour
- the role of CAD/CAM
- feasibility of upgrading existing machine tools.

The seven-stage plan comprised:

(a) Mechanical engineering manufacture from basic metalworking casting, forging, machining, fitting and assembly to precision standards equal to or better than the machine tool under construction;

(b) Automation application engineering in pneumatics, hydraulics, electrics and tooling technology;

(c) Control engineering. Application of electronic logic control to machine tool operating techniques;

(d) NC engineering. Part programming. Interfacing controls with machine tools. Variable speed D.C. and A.C. drives. Closed loop positioning systems for actuation of tool slides;

(e) CNC engineering. Programme edit facilities on machine controller, automation of work handling, automated inspection, interactive (CAD) programming aids;

(f) DNC engineering. Remote programming of CNC machine tool. Use of data highways to link central computer with individual machines; and

(g) FMS. Automated cell manufacture for the manufacture of sets of parts. Computer aids for scheduling, part programming and selection, material handling.

Finally, some policy issues emerged from the presentation, in which the following must be pointed out:

- The government is seen to be the prime mover in promoting all aspects of machine in the industry.
- The machine tool industry is possibly unique from other industries with the exception of aerospace in that it encompasses a total range of technology from mechanical, electrical, hydraulic, control engineering, computing and tooling skills.
- In world marketing terms the machine tool industry is often referred to as the toughest business to be in because every new improvement in performance, quality and cost, no matter how small, must be exploited to the full in the shorter possible time to maintain a competitive position in manfacturing industries.
- Modern computer controlled machines now tend to be in a class of their own and bear only superficial resemblance to conventional manually operated machines.
- The impact of modern cutting technology has enabled high speed machining of hard materials which were inconceivable twenty years ago and which are unattainable on conventional manual machines.
- There is scope for converting existing machine tools to semi-automatic and automatic sequence control but little practical possibility of conversion to full CNC. The biggest area for improvement is seen to be in the adoption of digital readout systems for the benefit of all manually operated machines.
- Long-term future for the industry may best be secured on the basis of license deals incorporating full technological transfer, initially as agency deals, then assembly of kits of parts, followed ultimately by total self sufficiency and full manufacture. The license deals should include specialist equipment manufacture of drive systems and CNC controls.

D. <u>The machine tool industry in ASEAN countries - a summary of the presentation by Mr. Faruque</u>

Mr. Faruque related to the UNIDO documents UNIDO/IS.634, and UNIDO/IS.634/Add.I and indicated that most existing machine tool enterprises in the ASEAN countries are relatively small ones. While most indeed produce simple machine tools (mostly presses, tool and dies, simple lathes, etc.), production is not performed on continuous basis. In fact, apart from one or two machine tool items in stock (presumably for display or promotion purposes) all other productions were done on job-order basis. Generally, intermittent and highly diversified production of machine tools results in low productivity, low capacity utilization, poor quality and longer delivery time in the short run. And in the long run, technology capacity build-up will be relatively slower, time to attain economic scale of production will be longer, and learning curves-related mistakes will be costlier.

He also described the situation of the machine tool industry in the context of the capital goods industry in ASEAN countries of the region viz. Indonesia, Malaysia, the Philippines, Singapore and Thailand.

In pursuit of a machine tool industry development, the government of Indonesia promulgated specific policies to stimulate local manufacture of simple machine tool items. Recently there has been a significant growth - up to 20 per cent annually - of market demand for machine tool items. The Ministry of Industry recorded about nine local firms to have successfully produced simple machine tools for the domestic market.

The existing enterprises are mostly utilizing non-precision machine tool items in the production department. They are unable to modernize their set-up to inadequate resource availability coupled with high interest on borrowed money from the banks. Due to a poor sales network, these firms have very slow growth rates. The raw materials are available on the market at a very high price. The support services from good quality heat treatment shops, special machining services and casting/forging facilities are very difficult to obtain.

In the short-term, it is recommended that current development projects be accelerated and further assistance be given to existing and potential manufacturers. Basic technology involving precision products, basic metal, engineering/designing and quality control should be taught, supported by extension services.

In the long-run, mass production needs to be encouraged. National R&D programmes should be initiated through existing institutions. Investment by private companies should be promoted through joint-venture arrangements, foreign investment schemes, licensing agreements, tax incentives and rebates, import restrictions, sales guarantees, and credit assistance.

In Malaysia, strategically, the use of modern machine tool items is more emphasised in the production of capital goods rather than the manufacture of machine tools per se. A few local firms are trying to produce metal forming machine tools for the domestic markets. Malaysia is essentially dependent on importation of all major machine tool items. There has been a significant increase in the importation of sophisticated machine tool products in recent times.

The trend in Malaysia's precision engineering development will provide a favourable condition for the promotion of machine tool industries in the near future. It is recommended that the technical capabilities of all supporting sectors of the machine tool industries like casting, forging, heat treatment, precision machining and gear cutting be upgraded gradually with the assistance of several existing promotional organizations. To increase productivity, the use of modern machine tools can be introduced through organizing special training courses on NC/CNC machine tools.

In the long run, efforts should be made to promote private investments in machine tools by measures such as tax incentives, import restrictions, sales guarantees and credit assistance. It is also recommended that a national institute (SIRIM) should formulate standards and provide assistance in the design and development of machine tools.

In the Philippines, despite government incentives being available, since the curtailment of MATOOLS in 1979, there is no new recognized machine tool manufacturer. This was because of the pessimistic industrial outlook. Instead, there is an increase in the import of second hand machines. However, there exist a few small enterprises which are manufacturing simple machine tools for the domestic market.

The machine tool industry in the Philippines is hit by poor demand and stiff competition from overseas producers. The high interest rate deters the import of new machines required to modernize existing set-ups. The raw materials are available at a very high cost. High rates of interest on bank loans discourage the producers from investing. Generally, the producers are experiencing very poor demand for their products. As a long-term measure to boost the performance of this sector, the Government should extend tax incentives, import restrictions, sales guarantees and credit assistance.

Manufacturing is playing an increasingly important role in the economy of Singapore primarily due to the dynamic private sector, excellent industrial infrastructure and the continuing influx of foreign investment. In recent years, Singapore has been able to establish a strong supporting industries' network for machine tool makers. The majority of the machine tool makers are foreign firms. The local firms, through associating these foreign firms, are successfully acquiring manufacturing and managerial capability in machine tool production. Generally, the Singapore machine tool manufacturers are not affected by any major domestic problem. They are, however, finding it difficult to export their products overseas.

It is recommended that the development institutions in Singapore should pursue specific programmes for enhancing the design and engineering capability of the local firms. Specialized training courses for engineers and technicians should be organized to meet the needs of the machine tool sector. Study tours for machine tool makers in more advanced countries should be organized for the local manufacturers. The firms involved in export marketing should get latest market trends information from the trade promotional bodies.

In the long run, a national institute SISIR, should undertake formulation of national standards. This institute should also facilitate testing and standard marks for the products. Subcontracting work in machine tool building should be encouraged and subsidies should be given to local producers to attend international fairs.

Thailand has underscored the need for developing the machine tool sector through providing various incentive schemes to the investors. There has been a significant technological improvement in the machine tool sector in the form of increased modern machine tool uses. A few promotional projects have been undertaken to accelerate the growth of the machine tool sector.

There are nearly a dozen manufacturers engaged in producing metal cutting and metal forming machine tools. Generally, however, the production volume is carried out in small batches. The manufacturers are beset by marketing problems in terms of stiff competition with the foreign brands. High rates of interest on bank loans are discouraging additional investment in the existing enterprises.

Short-run measures should be taken to assist existing manufacturers in areas of technical support, sales promotion, management improvement and marketing. Extension and training efforts should be channelled into casting, gear making, heat treatment and forging techniques.

As a long-term measure, the Government should initiate broad economic measures like tax incentives, import restrictions, sales guarantees and credit assistance schemes to promote the growth of the machine tool industries.

Mr. Faruque also referred to the technology issues in the region. In fact he mentioned that the existing machine tool manufacturing technology level within the region - except in Singapore's case - is relatively low. The survey likewise observed the prevalence of old machines (more than 10 years old) within the industry. While some are apparently unusable, these machines are still maintained within the factory. The operable machines are not properly maintained and the tolerances are not checked regularly. Low productivity and low capacity utilization (specially, if one includes the unusable machines which continue to occupy otherwise productive spaces) prevail in the industry.

Except in Indonesia's case, no specific policy statement to intensify machine tool industry promotion and development has been issued by the ASEAN member countries, besides the usual investment incentives. The absence of specific policy statements spawned a cornucopia of approaches which each country considers unique and appropriate.

For example, in its effort to attract high technology investments, Singapore has consciously developed its machine tool industry conveniently employing the latest technology trimmings (CNC, machining centres, etc.). While heavily relying on its existing technology resources, Thailand has persistently produced intermediate technology level machine tools (presses, shearing, forging hammers, jigs and fixtures, etc.). While undergoing a painful economic adjustment process, the Philippines founded a machine tool reconditioning and rebuilding industry (in the last two years, 30 or 40 per cent of imported machines were reconditioned or brought in for reconditioning). And while aggressively developing its capital goods industry, Malaysia like Singapore, might also unknowingly develop its machine tool industry. But much unlike the others, Indonesia has initiated a modest simple standard machine tool development policy.

For the ASEAN region, Mr. Faruque pointed out the following: Essentially, three major technology-related issues must be resolved. These are:

(a) Where should ASEAN and its member countries focus the machine tools technology development?

(b) What are the required technology development institutions to attain the focus chosen? and

(c) How should the technology be mastered?

(a) Technology development directions

The region's predominantly low machine tool manufacturing technology levels open three product-oriented technology development options. First, high level machine tool technologies which produce wire cut machines, EDMs, EEMs, CNCs, NCs, milling machines, etc. Second, medium level machine tool technologies which produce precision lathes, grinders and other special purpose machines. And third, low level machine tool technologies which produce simple lathes, grinders, presses, shearing machines, punching presses, etc. Obviously, Indonesia has opted for low level and local market appropriate machine tool manufacturing technology. Singapore chose the high level technologies. While Malaysia, the Philippines and Thailand preferred the medium or intermediate level. But what seemed apparent is that machine tool technology choices - decisions which are sensitive to market developments - are being made in the absence of appropriate in-country policies. The direction will define the required policy options, policy implementation mechanisms and commitment from all parties concerned.

(b) Technology development institutions

Technology development institutions consist of the supporting industries and R,D&E institutions. The supporting industries (casting, forging, heat treatment, gear-cutting, etc.) which are vital to the development of machine tools are still inadequately prepared for the machine tool industry in all countries except Singapore. With respect to R&D institutions, the survey noted that no one was especially servicing the machine tool industry. The existing development institutions execute machine tool related programmes which are not sustained over a relatively longer time period.

(c) Technology mastery

Usually taken for granted, technology mastery ensures the effective assimilation and utilization of technology resources. In formulating national initiatives to develop machine tool industries, the indigenous technology mastery is a critical input. This is particularly present in the machine tool industry's case, the technology of which involves significant complexities.

E. Local needs of machine tools in LDCs of the ESCAP region - a summary of the presentation by Mr. Ovseenko

In the presentation on the situation of the machine tool industry in LDC's, Mr. Ovseenko referred to the field analysis carried out on Nepal and Sri Lanka. These two countries denote similarities in the techno-economic development of this industry.

In the case of Nepal, he further pointed out that the mechanical workshops (general engineering and automatic) form the nucleus of the metalworking industry, namely general engineering workshops and automotive engine repair workshops. The workshops are situated in the Mathmandu Valley in the central and south east regions of the country.

The modest machine stock is not fully utilized in the general engineering workshops. The main constraints are the lack of market development by workshop management, delays in importing raw materials, spare parts and equipment, as well as design capacity, standardization and metrology.

The country is meeting the problem of the skilled labour training, is developing a rapidly hydroelectric power sector and adequate industrial infrastructure, which allow the establishment of a medium sized factory producing hand tools and power driven hand tools for the metalworking and the wood cutting industries.

In the case of Sri Lanka, Mr. Ovseenko pointed out the role played by the Industrial Development Board of Ceylon (IDB) in promoting the production of machine tools. In this context, the IDB produced samples of simple machine tools such as hole punchers, piper benders, sheet cutters, sheet rollers and sheet formers, which can be installed free-of-charge. These machine tools can then be manufactured by companies under license from IDB which charge only a small license fee.

The presentation also indicated that the metalworking industry of Sri Lanka has grown considerably in recent years. The industry is a mixture of small, medium-sized and large enterprises, some of which have been operating for more than 50 years. The metalworking industry produces mainly rolled steel and cold-drawn-wire products, cast iron, steel casting, non-ferrous castings, rubber and paddy-processing equipment, simple machine tools, dies, jigs and fixtures. However, the manufacturing technology workshop operation, quality control and safety techniques are below modern industrial standards.

3. CONCLUSIONS AND RECOMMENDATIONS

The Technical Working Group concluded that the degree of development of the machine tools industry in ESCAP developing countries has reached different levels which are directly related to the development of the capital goods industries in general and in particular, the metalworking industry. The countries are urged to consider that the introduction of NC services and components in the machine tool production and/or use must be structured within the following guidelines.

(a) The problem of the entry into conventional machine tool production and a clear cut differentiation of the upgrading required to achieve higher technological level, such as CNC control systems in those countries which already have reached some degree of development as producer or net user of machine tools;

(b) The technological requirements of the machine tool production and the possibilities for upgrading the industry through strengthening the use of the available resources and indigenous capabilities; and

(c) The international co-operation framework among Asian countries in the promotion of study tours, training of trainers, exchange of technical information in CAD/CAM.

The participants concluded that the Technical Working Group provided an excellent opportunity to exchange views on the new technological developments influencing the machine tool industry worldwide. They stressed the importance of the studies undertaken at regional and country levels and requested ESCAP and UNIDO to continue a further analysis of this industry. This analysis should provide an insight into details for the formulation of a long-term strategy and it should be undertaken at firm/country level considering the international techno-economic context affecting the development of the machine tool industry. The formulation of the strategy should be based on an analysis of inter-alia:

(a) Different degrees of development of the machine tool industry, considering both their production and use;

(b) Main points concerning the supply and demand of machine tools and NC machine tools considering:

- market size;
- questions of scale with particular emphasis on the role of small and medium scale enterprises;
- use of local resources and availability of raw material and other inputs;
- strengthening of technological capacities;
- skills constraints;
- standardization of components;
- hartnessing of entrepreneurship;
- research and development capabilities; and

(c) Issues relating to domestic and international co-operation as well as adequate project preparation for seeking technical assistance from UNIDO and ESCAP.

The Technical Working Group also concluded that based on the discussions summarized in this final report, it is urgent for ESCAP developing countries to be aware that a successful machine tool policy is only possible if there is a previous identification regarding:

(a) Targets for the kind of machine tools (conventional or NC machine tools) to be produced according to their markets (internal-external) and the planning requirements withdue regard to intersectoral linkages and technological requirements;

(b) The institutional framework necessary to support and reinforce national production or use capability; and

(c) National development policies to be adopted in conjunction with import duties, financing and investment.

The Technical Working Group based on the Summary of Discussions presented in section III of the present report and taking into consideration the conclusions mentioned above, recommend that UNIDO and ESCAP undertake joint activities at regional and national level in order to promote a harmonious development in the production and/or use of machine tools, considering the following issues:

(a) Technology through NC/CNC machine awareness programmes. The programmes should be designed in the first instance to highlight the importance of assessing current manufacturing resources in terms of plant, machinery, people and production management systems in order to focus on areas where computer aids may be shown to assist existing organizations in terms of increased productivity, improved quality, reduced cost and improved delivery times;

(b) Training of human resources through skill developments at management level and at workshop level, specially through a programme of training of trainers;

(c) Enterprise-to-enterprise co-operation in design, drawing, software, standardization, etc.; and

(d) Regional co-operation by means of exchange of information, trainingg, study tours and organization of specialized meetings and seminars such as use of CAD/CAM, etc.

In particular, the Technical Working Group recommends that UNIDO and ESCAP, jointly with non-governmental organizations such as TECHNONET ASIA, undertake the following activities, at regional and country level:

A. Regional level

The participants recommended that UNIDO and ESCAP promote a closer South-South co-operation in the promotion of regional projects to strengthen the exchange of information through the establishment of a Regional Network on Machine Tools, to be based in one of the already existing institutions of the area. The main task of the Regional Network will be to

provide information and advice to the less advanced countries of the region seeking the establishment or upgrading of their machine tools industry. In this context, People's Republic of China may be interested in promoting jointly with UNIDO technical assistance programmes at regional level, to be focussed in two areas.

(a) Strengthening of training capabilities

The projects will comprise two components. As a first step, a study tour for managers to selected machine tools firms in Asia will be organized. The managers will visit the Chinese machine tools producers in Shanghai, Beijing and Shenyang, for a period of two weeks.

The main objective will be to present the range of machine tools produced by the People's Republic of China first hand and to determine whether some of them are operable in developing countries of Asia attending the study tour.

Based on the machine tools technology, a training programme for design manufacture and operations will be designed. The main idea behind this course will be the training of trainers, who will then continue with the formation of other operator training groups in the relevant countries of Asia.

(b) Regional meeting of Asian machine tools manufacturers

As a follow-up of the Technical Working Group held in Singapore on production and use of machine tools in the engineering industry of ESCAP developing countries, the People's Republic of China is interested in promoting the exchange of information on the machine tool industry of the region, by means of hosting a meeting of experts in 1987 sponsored by UNIDO. The main objective of the meeting will be to consider the creation of a Regional Information Network on Machine Tools based in one of the developing countries of Asia and to analyse the possibility for the creation of an association among manufacturers of machine tools in the region, with the main objective of promoting exchange of technical information, introduction and upgrading of existing machine tool industry, standardization and promotion of enterprise-to-enterprise co-operation. Modalities for implementation of the projects mentioned above will be agreed between UNIDO, the People's Republic of China Mission to UNIDO and the Ministry of Machine Building Industry, Beijing, People's Republic of China.

The participants recommended that UNIDO define a framework of regional co-operation with the Indian Government at the Central Machine Tool Institute in Bangalore, in order to consider the following services for TCDC with other developing countries of the ESCAP region:

(a) Training of manpower for management and development of CNC machine tools as well as conventional machine tools, at the Central Machine Tool Institute Bangalore;

(b) Visit to Prototype Development and Training Centres of India and assisting in setting-up of similar institutions in other developing countries;

(c) Selection of suitable experts for identification of machine tools for indigenous manufacture and making feasibility or project reports; and

(d) For a large variety of conventional metal cutting and metal forming machine tools, technology transfer arrangements can be made through both public sector and private sector units. The technology package, depending on the choice of recipient, may include elements such as feasibility, project report, machine tool designs, production technology, choice of equipment, layout, manpower training or even financial investment in equity.

The participants to the Technical Working Group strongly recommended that the conclusions and recommendations adopted in the Workshop on Computer Application in Engineering held in Nanjing from 24 to 28 August 1985 organized by UNIDO (project no.UC/UD/RAS/84/036) should be given a further follow-up as specified in the final report of this workshop, as follows:

(a) The several needs to introduce Computer Applications in Engineering (CAE) in developing countries which have reached even a low level of industrialization;

(b) A mechanism which should be developed to facilitate the exchange of CAE technology among developing countries in the form of information, personnel and software; and

(c) The creation of a national/regional organization within each country/region which will introduce and disseminate CAE technology.

B. Project proposals at country level

Based on the answers to the Questionnaire and on the studies prepared by UNIDO and ESCAP on the situation of the machine tools industry in the countries, the participants have identified some priority areas which are considered to be of paramount importance for technical assistance from UNIDO. In a further elaboration of the requests the corresponding project proposals were formulated at country level.

The project proposals are presented as annex IV of the present report and are based on the concepts elaborated by the participants.

The participants agreed to discuss and confirm elaborated project proposals with local authorities in terms of UNDP/UNIDO/ESCAP input and substantial contents. In the event of a positive decision, a request for UNDP/UNIDO/ESCAP assistance should be officially sent through UNDP Resident Representative in order to prepare a project document and to field programming mission to discuss the detailed plan of implementation. The participants admit that the successful implementation of the project can be reached only if a very well elaborated project concept is presented according to the UNIDO methodologies and the full support from the national counterpart is secured.

Annex I

List of participants

1. National Experts

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Mr. CALDERA, Deleratne Mudalige Jayasoma, Mechanical Engineer, National Engineering R and D Centre, Industrial Estate, Ekala, Jaela, Sri Lanka

Mr. CHAN Kai Mun, Senior Industry Officer, Economic Development Board, 1 Maritime Square, World Trade Centre #10-40, Singapore 0409

Mr. HISAMUDDIN, Operational Head, M.R.H.T. Pakistan Steel Bin Qasim Karachi, Pakistan

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Mr. KIM, Dong-Chul, Director, Ministry of Trade and Industry Kuachon. Kyonki-do, 171-11, Seoul, Republic of Korea

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Mr. PALHAN, S.K., Industrial Adviser, D.G.T.D., Ministry of Industry, Ydyog Bhawan, New Delhi, India

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Mr. THAPA, Indu Shamsher, Project Director, HMG/NEPAL, Ministry of Industry, Tripureswar, Kathmandu, Nepal

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2. International Experts

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3. UNIDO Secretariat

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Mr. ZIELINSKI, R., UNIDO Special Technical Adviser, UNIDO

4. ESCAP Secretariat

Mr. OVSEENKO, Felix V., Section Chief, ESCAP, c/o ESCAP/UNIDO Division of Industry, Human Settlements and Technology, Bangkok, Thailand

Mr. NEUBAUER, Gerd, Associate Expert, ESCAP, c/o ESCAP/UNIDO Division of Industry, Human Settlements and Technology, Bangkok, Thailand

5. TECHNONET ASIA, Singapore

Dr. CHICO, Leon V., Executive Director, TECHNONET ASIA, Tanglin, P.O. Box 160, Singapore 9124

Mr. FARUQUE, Shahabuddin, Industrial Development Officer

Mrs. SIM, Mary F., Project Coordinator/Editor

Mrs. LIM, Lina, Secretary/Project Assistant

Mrs. KAM, Rina, Secretary

Annex II

UNIDO/ESCAP Technical Working Group on production and use of machine tools in the engineering industry in ESCAP developing countries Singapore, 17-21 November 1986

PROGRAMME

Monday, 17 November

Morning:	08.30	Registration: Rose Room, York Hotel
	09.00	Opening of the Technical Working Group - Dr. Leon V. Chico, TECHNONET - Mr. F. Ovseenko, ESCAP - Mr. L. Pineda, UNIDO Election of Officers Adoption of Agenda
	10.30	Coffee break
	10.45	Presentation of issues, main topics for discussion
	12.30	LUNCH
Afternoon:	14.15	The role of computerized technology in manufacturing process, by Mr. R. Zielinski, Special Technical Adviser, UNIDO, Vienna
	15.30	Coffee break
	15.45	Discussion
	17.00	Main conclusions

Tuesday, 18 November

Morning:	09.00	The situation of industrial automation in industrialized countries, with emphasis on CNC machine tools and perspectives for developing countries, by Prof. Charles Edquist, Lund, Sweden, UNIDO Consultant
	10.00	Discussion
	10.30	Coffee break
	10.45	Technological requirements to entry into the machine tool industry and the upgrading to CNC machine tools, by Mr. E.J. Wightman, UNIDO Consultant
	11.00	Discussion
	12.30	LUNCH

Afternoon:	14.15	Country experiences of the ESCAP countries the machine tool industry in the ASEAN region: Options and strategies. Analysis by country, by TECHNONET
	15.00	Discussion
	15.30	Coffee break
	15.45	The machine tool industry in the ASEAN region: main issues at regional level and the experiences of the Republic of Korea, India and People's Republic of China
	16.30	Discussion
	17.00	Main conclusions

Wednesday, 19 November

Morning:	09.00	Local needs of machine tools in the LDCs of the ESCAP region. The cases of Nepal and Sri Lanka, by ESCAP/UNIDO Division of Industry, Human Settlements and Technology
	10.00	Discussion
	10.30	Coffee break
	10.45	Round table: The perspectives of ASEAN countries to provide TCDC in the machine tool to the LDCs of ESCAP region
	12.30	LUNCH offered by TECHNONET
Afternoon:	14.30	UNIDOs Technical Assistance to the machine tool industry of developing countries
	15.30	Coffee break
	15.43	Summary session. Main issues to be included in the final report
	17.00	Main conclusions

Thursday, 20 November — TECHNICAL VISITS
(see special attached programme for this day)

Friday, 21 November

Morning:	09.00	Presentation of the final report by the Secretariat and Rapporteur

10.30 Coffee break

10.45 Adoption of the report of the Technical Working Group

12.00 Closing session

Afternoon: Visit to Metal Asia Exhibition

SECRETARIAT

- **Mr. S. Faruque, TECHNONET ASIA**
- **Mr. L. Pineda, UNIDO, Sectoral Studies Branch, Vienna**
- **Mr. R. Zielinski, UNIDO, Engineering Branch, Vienna**
- **Mr. F. Ovseenko, ESCAP/UNIDO Division of Industry, Human Settlements and Technology, Bangkok**
- **Mr. G. Neubauer, ESCAP/UNIDO Division of Industry, Human Settlements and Technology, Bangkok**

ESCAP/UNIDO Technical Working Group Meeting on
production and use of machine tools in the engineering industry
in ESCAP developing countries
Singapore, 17-21 November 1986

SCHEDULE OF PLANT VISITS

Thursday, 20 November 1986

08.00 Pick up participants at York Hotel

08.30 Arrive at Amtek Engineering Pte. Ltd.
9 Kian Teck Drive
Singapore 2262

Telephone: 264 0033

Contact: Mr. Tony Tan
Marketing Manager

10.00 Leave for Okamoto (S) Pte. Ltd.

11.00 Arrive at Okamoto (S) Pte. Ltd.
No. 10 Riverside Road
Off Marsiling Lane
Singapore 2573

Telephone: 269 6426

Contact: Mr. Lau Chung Keong
Marketing Manager

12.30 Lunch (hosted by Okamoto (S) Pte. Ltd.)

13.30 Leave for LeBlond Makino Asia Pte. Ltd.

15.30 Arrive at LeBlond Makino Asia Pte. Ltd.
2 Gul Avenue
Singapore 2262

Telephone: 861 5722

Contact: Mr. Lim Cho Keon
Managing Director

16.00 Leave for York Hotel

Annex III

List of documents

1. Background documents

- UNIDO, The Machine Tool Industry in the ASEAN Region: Options and Strategies. Main issues at regional level. Sectoral Working Paper Series, No. 49, Volume I (1986), UNIDO/IS.634
- UNIDO, The Machine Tool Industry in the ASEAN Region: Options and Strategies. Analysis by country. Sectoral Working Paper Series, No. 49, Volume II (1986), UNIDO/IS.634/Add. 1
- UNIDO, Technological Requirements for the Machine Tool Industry in Developing Countries. Sectoral Working Paper Series, No. 51 (1986), UNIDO/IS.642
- UNIDO, The Role of Computerized Technology in Manufacturing Process, by R. Zielinski, Special Technical Adviser, Engineering Branch
- ESCAP, Local Needs of Machine Tools in the LDCs of the ESCAP Region, Implications for Nepal and Sri Lanka, 1986

2. Information documents

- UNIDO, Technological Perspectives in the Machine Tool Industry and Their Implications for Developing Countries. Development and Transfer of Technology Series, No. 19 (1985), UNIDO/ID.312
- UNIDO, Selected Aspects of Microelectronics Technology and Applications: Custom and Semi-Custom Integrated Circuits. Technology Trends Series No. 1 (1986), UNIDO/IS.631
- UNIDO, Selected Aspects of Microelectronics Technology and Applications: Numerically Controlled Machine Tools. Technology Trends Series No. 2, UNIDO/IS.632

3. Country cases

The following country cases were furnished by participants:

- Strategies and guidelines to vitalize the machine tool and tool industry of People's Republic of China
- The machine tool industry in Thailand
- Status of the machine tool industry in the Philippines, 1986
- Country paper of the Socialist Republic of the Union of Burma
- The machine tool industry of the Republic of Korea
- The machine tool industry in India
- The machine tool industry in Malaysia
- The machine tool industry in Nepal.

Annex IV

Project proposals on the technical assistance
to the machine tools industry identified at country level

BURMA

Project proposal/Title

Development of CNC machine tools design, manufacturing and utilization.

Project duration: 5 years

UNDP/UNIDO inputs required: $US 1.5 million.

INDIA

Project proposal/Title

Development of flexible manufacturing system (FMS)

Project duration: 3 years

UNDP/UNIDO inputs required: $US 2.5 million.

REPUBLIC OF KOREA

Project proposal/Title

Development of control systems for numerically controlled machine tools.

Project duration: 3 years

UNDP/UNIDO inputs required: $US 4.8 million.

MALAYSIA

Project proposal/Title

Assistance in computer's applications within heavy and precision industry

Project duration: 2 years

UNDP/UNIDO inputs required: $US 550,000

NEPAL

Project proposal/Title

Feasibility study for the establishment of hand tools and power driven tools production

Project duration: 2 months

UNDP/UNIDO inputs required: $US 35,000

Project proposal/Title:

Assistance in establishment of Prototyping and Training Centre for machine tools and products development

Project duration: 3 years

UNDP/UNIDO inputs required: $US 300,000

PEOPLE'S REPUBLIC OF CHINA

Project proposal/Title:

Promotion of CNC machine tools utilization and CAE activities within machine tool industry

Project duration: 3.5 years

UNDP/UNIDO inputs required: $US 9 million.

PHILIPPINES

Project proposal/Title:

Establishment of CNC centre for demonstration and training purposes

Project duration: 2.5 years

UNDP/UNIDO inputs required: $US 500,000

SRI LANKA

Project proposal/Title:

Assistance in upgrading country's industries by introducing NC technique within engineering industry

Project duration: 3 years

UNDP/UNIDO inputs required: $US 720,000

THAILAND

Project proposal/Title:

Strengthening the existing machine tool industry by developing NC technique in design and manufacturing

Project duration: 4 years

UNDP/UNIDO inputs required: $US 770,000

ESCAP/UNIDO/TECHNONET

Workshop proposal/Title:

Workshop on CAE application in medium- and small-scale metalworking industries in Asia Pacific countries

Workshop duration: **2 weeks**

Inputs required: **$US 60,000**

EXTRACTO

El presente documento contiene el informe final del Grupo de Trabajo Técnico en producción y uso de máquinas herramientas en las industrias de ingeniería de los países en desarrollo de la ESCAP, el cual se celebró en Singapore entre el 17 y el 21 de Noviembre de 1986.

El principal objetivo del Grupo de Trabajo Técnico fué el de analizar los problemas que enfrentan las industrias de ingeniería de los países en la producción, utilización, mantenimiento y reparación de máquinas herramientas y sus accesorios, con enfásis en la introducción y uso de máquinas herramientas de control número.

Los participantes en el Grupo de Trabajo Técnico formularon conclusiones y recomendaciones concretas tanto a nivel regional como nacional, las cuales cubren programas de difusión de tecnologías CN/CNC; la capacitación de recursos humanos tanto a nivel de administración como de planta; la co-operación técnica entre países en desarrollo a través de capacitación, reuniones especializadas y seminarios, tales como uso de CAD/CAM y CAE. A nivel nacional once proyectos fueron identificados para que tanto usuarios como productores de máquinas herramientas de la región reciban asistencia técnica de UNIDO.

SOMMAIRE

Le présent document constitue le rapport final du Groupe de Travail Technique réuni à Singapour entre les 17 et 21 novembre 1986 pour discuter de la production et de l'emploi de machines-outils dans l'industrie d'ingénierie des pays en développement de la Commission économique et sociale pour l'Asie et le Pacifique (CESAP).

Ce Groupe de Travail Technique avait pour objectif principal d'analyser les problèmes que doivent affronter les industries d'ingénierie de ces pays quand il s'agit de produire, d'utiliser, d'assurer la maintenance ou la réparation de machines-outils et de leurs accessoires et particulièrement en ce qui a trait à l'introduction de l'informatique dans ce sous-secteur.

Les participants au Groupe de Travail Technique adoptèrent des conclusions et recommandations concrètes aux niveaux régional et national, à savoir des programmes de diffusion technologique CN/CNC, de formation de ressources humaines à la fois pour l'administration et pour l'usine, de coopération technique entre pays en développement par l'intermédiaire de training, de réunions spécialisées ou de séminaires, tout comme dans l'utilisation de CAD/CAM et CAE. Au niveau national, onze projets furent identifiés où l'ONUDI pourrait accorder une assistance technique aux usagers aussi bien qu'aux producteurs de machines-outils dans cette région.

For the guidance of our publications programme in order to assist in our publication activities, we would appreciate your completing the questionnaire below and returning it to UNIDO, Studies and Research Division, D-2119, P.O. Box 300, A-1400 Vienna, Austria

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Q U E S T I O N N A I R E

Production and use of machine tools in the engineering industry of ESCAP developing countries

	(please check appropriate box) yes	no
(1) Were the data contained in the study useful?	☐	☐
(2) Was the analysis sound?	☐	☐
(3) Was the information provided new?	☐	☐
(4) Did you agree with the conclusion?	☐	☐
(5) Did you find the recommendations sound?	☐	☐
(6) Were the format and style easy to read?	☐	☐
(7) Do you wish to be put on our documents mailing list?	☐	☐
If yes, please specify subjects of interest		
(8) Do you wish to receive the latest list of documents prepared by Studies and Research Division?	☐	☐
(9) Any other comments?		

Name:
(in capitals) .....

Institution:
(please give full address) .....

Date: .....